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ABSTRACT

This study investigated the effect of different implicit definitions of equality upon children's performance on conservation tasks. In the study, traditional versions of conservation tasks are compared to modified versions in which initial equality is established through verbal counting of discontinuous quantities and measuring of continuous quantities. A group of 48 children, 4 and 5 years of age, were tested in either a traditional or modified form of the conservation task with discontinuous quantities. A second 48 were tested in either a traditional or modified form of the conservation task with continuous quantities. All children came from middle-class families and attended private nursery schools in Recife, Brazil. Results indicated that significantly more 5-year-olds conserved discontinuous and continuous quantities when equality was not established perceptually. Subjects who were 4 years old did not improve significantly in either task. Furthermore, 4-year-olds had difficulty in accepting the initial equality in the modified version of the task with continuous, but not discontinuous, quantities. Some children denied equality after having accepted it on a nonperceptual basis. It is concluded that though the interference of an implicit definition of equality as perceptual is important, it is not sufficient to explain the lack of conservation among children 4 and 5 years of age. (RH)

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REAL AND APPARENT EQUALITY IN CONSERVATION TASKS

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ABSTRACT

Social situations work with so many implicit definitions that psychologists must ask themselves which implicit rules they unwittingly create in their experiments. The definition of "what we are doing here" may depend upon how data are presented to children in a problem.

This study investigates the implicit definition of equality in conservation tasks. When equality is initially established on perceptual grounds, this procedure could be interpreted by some children as defining the type of equality under discussion.

Ninety-six four and five year olds were tested either in conservation of discontinuous (marbles) or continuous (ribbons) quantities. Form of presentation of the initial equality was perceptual or established by comparison to a mediating resource (counting for marbles and measuring for ribbons).

Significantly more five-year olds conserved when equality was not established perceptually both with continuous and discontinuous quantities. Four-year olds, however, did not improve significantly in either task. Furthermore, four-year-olds had difficulty in accepting the initial equality in the modified version of the task with continuous but not with discontinuous quantities. However, some children still denied equality after having accepted it on non-perceptual basis. Thus, the interference of an implicit definition of equality as perceptual, even though important, is not sufficient to explain the lack of conservation among four and five year olds.

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Social situations work with so many implict definitions that experimental psychologists must continually ask themselves which implicit rules they have unwittingly created in their experiments. Work on mathematical concepts has led anthropologists (e.g., Lave, Murtaugh & de la Rocha, 1984) and psychologists (e.g., Carraher, Carraher and Schliemann. 1987) to suggest that problem solving in schools is perceived as calling for a particular type of procedure, which may neither be the most effective for the subject nor the prefered one outside school and experimental situations. The definition of "what we are doing together in this setting" may be an important determinant of which tools for thinking the subject decides to draw upon. If one takes the case of the conservation experiment as an example, it is easy to recognize that adults may use several distinct tools for establishing equality--e.g., direct perceptual comparisons, counting, measuring, reconstructing the transformations performed in the situation, estimating (as in compensation of height and width). This ability to rely on varied means for establishing equality and to turn to those better suited to specific situations is essential for the efficient use of our mathematical competence. Developmental psychologists have perhaps emphasized too much the question of whether children do or do not have any of the specific abilities underlying the understanding of equality and may not have given enough attention to the distinction which Bryant (1985) has brought up under the contrast "knowing how" and "knowing when" to do something. Even if we know how to measure, for example, we may not measure under certain circumstances in which this ability would be called for either because that situation is not one which we subsume under the concept of measurement or because we have assumptions about the situation which lead us to give up measurement.

"Knowing when" to use an ability can be seen as peripheral or central knowledge depending on how concepts and abilities are conceived in the theory one uses. Developmental psychologists seem to have favored a position which treats "knowing when" as peripheral knowledge. They have concentrated their efforts in the search for situations which define the presence of an ability as early as possible in order to establish whether young children do or do not have certain important concepts. Conservation is the most typical example. Following

Piaget and Szeminska's (1941) initial study, many efforts concentrated on either training the ability to conserve or obtaining through experimental manipulations conservation responses at younger age levels. This approach has led Gelman to suggest that "as we continue to show capacities at an earlier and earlier age, it is hard to resist the idea that there are foundations for cognitive development which are innate and specific to a particular domain" (1982, p.219) and that new abilities will be confined to accessing the innate abilities.

There are, however, reasons for treating "knowing when" to use an ability as a central aspect of knowledge. Recent studies (Carpenter & Moser, 1982; Greeno, 1982; Vergnaud, 1982) on addition and subtraction, for example, have shown that problems which are solved through the same arithmetic operation may have drastically different degrees of difficulty. "Knowing when" can be conceived as defining both the extension of a concept and its organization.

If we think of the various tools that we dispose of for establishing equality, the conservation experiment can be defined as a situation in which the subject must realize the inadequacy of perceptual comparisons under certain circumstances and resort to other means which we call "logical" such as one-to-one correspondence, transitivity or compensation. It is important that the child recognizes that direct perceptual comparisons, which under other circumstances are quite valid for the establishment of equality, do not constitute a valid procedure in this case.

Testing for the extension and organization of this concept should not be biased towards the use of just one procedure from the outset. In the traditional conservation study, the equality of the initial sets is obtained by a perceptual equivalence, which is then destroyed in the crucial conservation question. When this procedure is used, the "equality" question could be interpreted as a matter of "perceptual equality", providing an implicit definition of which procedures are called for. It is necessary to contrast this situation with others in which different procedures for establishing equivalence are initially used and consider their effect upon the conservation response in order to better understand the organization of children's concepts of equality. This study investigates the effect of different implicit definitions of equality upon performance on conservation tasks. Traditional versions of conservation tasks are compared to modified versions where the initial equality is established through different procedures--verbal counting in the case of marbles (A = B; B = B; thus A = B; the equality remains even if the displays do not look the same), and measuring the length of the ribbons with a stick in the case of the continuous quantities (A = C; B = C; thus A = B).

METHOD

Subjects

A group of 48 four- and five-year-old children were tested in either a traditional form of the conservation task or in a modified version with discontinuous quantities (marbles). Another group of 48 four- and five-year-olds was tested under either condition with continuous quantities (pieces of ribbon). All children came from middle-class families and attended private nursery schools in Recife, Brazil.

Procedure

Instructions and questions in both situations were the same, except for the initial equality question. In the traditional version, children were presented a row of marbles and asked to make another row with just as many marbles as the first one. For the continuous quantities task, children were shown two pieces of ribbon of the same size set on the table parallel to one another with their extremes next to each other.

In the modified version, the experimenter told the child to watch how many marbles she would put into her own box and counted them as she did so. She then asked the child to put just as many marbles into the child's box and count the marbles as they were put into the box. For the continuous quantities task, the experimenter measured a piece of ribbon from a roll against a stick, cut the piece out and put her ribbon inside her box. She then cut for the child a piece of ribbon using the same procedure and told the child to put the ribbon into the child's box. The first question regarding the equality of quantities was asked when these were inside the boxes and no perceptual comparison was possible. Children who did not admit the equality at this point were not interviewed further.

After the initial equality was established, the marbles were arranged by the experimenter in both versions of the task in rows of unequal length and the second equality question was asked. For the conservation of length, the experimenter arranged the ribbons in parallel lines with the end of one ribbon placed at approximately the middle of the other and asked the second equality question. After obtaining the child's response, the experimenter asked for justifications ("How do you know...").

Interviews were tape-recorded and evaluated by two independent judges who showed 98% of agreement in their judgements of the interviews about discontinuous quantities and 88% of agreement in their judgements of the interviews regarding continuous quantities. Disagreemnts were handled through a discussion of the transcripts.

RESULTS

The test of the difference between two independent proportions revealed that a significantly larger percentage of five-year-olds showed conservation responses in the modified version of the task as compared to the traditional one both with discontinuous and continuous quantities. Four-year-olds, however, did not improve significantly in either task. Furthermore, four-year-olds had difficulty in accepting the initial equality in the modified version of the task with continuous quantities but not with discontinuous quantities.

It seems that the procedure used in determining equality may be part of the implicit definition of "equality" in a conservation task. If children are able to establish that A = B because both equal C, it is more likely that they will distinguish between **looking** equal and **being** equal. Nonetheless, even when the bias provoked by an initial perceptual comparison is avoided, many children still resort to this method for evaluating equivalence. The interference of an implicit definition of equality as perceptual is not sufficient to explain lack of conservation among four- and five-year-olds.

The difference between results obtained with continuous and discontinuous quantities is open to diverse interpretations. While it is possible that the content of the task explains this difference, different mediators may also have diverse power in children's thinking, with counting being more powerful than measuring.

DISCUSSION

Gelman (1982) has demonstrated that three and four year olds "know how" to use both counting and one-to-one correspondence to correctly asses the equivalence of two rows of objects. The strong emphasis upon these procedures in her training methods was certainly sufficient to overcome children's tendency to rely on perceptual comparisons. However, one must not conclude that these young children have the same concept of equivalence as others, who spontaneously know when to choose "logical" procedures against conclusions drawn from perceptual equivalence. The organization of the concept in the latter children includes some kind of coordination of the different means for assessing equivalence and rules for choosing specific means under particular circumstances.

Table 1
Frequency of responses by task in the discrete quantities condition

Age group	Traditional Task n = 22			Modified Task n = 26		
	NA	NC	C	NA	NC	C
4 years	1	8	2	2	6	3
5 years	0	8	3	0	6	9
Total	1	16	5	2	12	12

NA = No acceptance of equality in the first equality question.
NC = Non conservation answer in the second equality question.
C = Conservation answer in the second equality question.

Table 2
Frequency of responses by task in the continuous quantities condition

Age group	Traditional Task n = 21			Modified Task n = 27		
	NA	NC	C	NA	NC	C
4 years	1	10	0	4	7	0
5 years	0	10	0	5	6	5
Total	1	20	0	9	13	5

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